Designation: D 2060 – 00

Standard Test Methods for Measuring Zipper Dimensions[1]

This standard is issued under the fixed designation D 2060; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover the measurement of the dimensions of all types and sizes of zippers.

1.2 The test methods appear as follows:

	Sections
Chain Flatness	34-39
Chain Straightness	40-44
Chain Thickness	28-33
Length of Zipper or Parts	9-14
Longitudinal Dimensional Change	45-52
Slider Mouth Width	21-27
Tape Width	15-20

1.3 The values stated in either SI units or in other units shall be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining values in any way.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 76 Specification for Tensile Testing Machines for Textiles[2]

D 123 Terminology Relating to Textile Materials[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 2050 Terminology Relating to Zippers[2]

D 2051 Test Method for Durability of Finish of Zippers to Laundering[2]

D 2052 Test Method for Colorfastness of Zippers to Drycleaning[2]

D 2053 Test Method for Colorfastness of Zippers to Light[2]

D 2054 Test Method for Colorfastness of Zipper Tapes to Crocking[2]

D 2057 Test Method for Colorfastness of Zippers to Laundering[2]

D 2058 Test Method for Durability of Finish of Zippers to Drycleaning[2]

D 2059 Test Method for Resistance of Zippers to Salt Spray (Fog)[2]

D 2061 Test Methods for Strength Tests for Zippers[2]

D 2062 Test Methods for Operability of Zippers[2]

D 2724 Test Methods for Bonded and Laminated Apparel Fabrics[2]

D 2905 Practice for Statements on Number of Specimens Required to Determine the Average Quality of Textiles[2]

D 3657 Specification for Zipper Dimensions[3]

D 3692 Practice for Selection of Zippers for Care-Labeled Apparel and Household Furnishings[3]

E 145 Specification for Gravity-Convection and Forced-Ventilation Ovens[4]

2.2 *AATCC Method:*

AATCC 143 Appearance of Apparel and Other Textile End Products After Repeated Home Launderings[5]

2.3 *Military Standard:*

MIL-105D Sampling Procedures and Tables for Inspection by Attributes[6]

3. Terminology

3.1 *Definitions*—For definitions of terms relating to zippers used in these test methods, refer to Terminology D 2050. For definitions of other textile terms, refer to Terminology D 123.

4. Significance and Use

4.1 The significance of specific tests is discussed in the appropriate sections.

4.2 These test methods are considered satisfactory for acceptance testing of commercial shipments because the test methods have been used extensively in the trade for this purpose, and because current estimates of between-laboratory precision are acceptable in most cases.

4.2.1 In case of a dispute arising from differences in reported test results when using Test Methods D 2060 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of

[1] These test methods are under the jurisdiction of ASTM Committee D13 on Textiles and are the direct responsibility of Subcommittee D13.54 on Subassemblies and were developed in cooperation with the Slide Fastener Assn., Inc.

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[2] *Annual Book of ASTM Standards*, Vol 07.01.

[3] *Annual Book of ASTM Standards*, Vol 07.02.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] Technical Manual of the American Association of Textile Chemists and Colorists, P. O. Box 12215, Research Triangle Park, NC 27709.

[6] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

bias. As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Student's *t*-test for unpaired data and an acceptable probability level chosen by the two parties before the testing is begun. If a bias if found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results in the light of the known bias.

4.3 The test method(s) in these test methods, along with those in Test Methods D 2051, D 2052, D 2053, D 2054, D 2057, D 2058, D 2059, D 2061, and D 2062, are a collection of proven test methods. They can be used as aids in the evaluation of zippers without the need for a thorough knowledge of zippers. The enumerated test methods do not provide for the evaluation of all zipper properties. Besides those properties measured by means of the enumerated test methods there are other properties that may be important for the satisfactory performance of a zipper. Test methods for measuring those properties have not been published either because no practical methods have yet been developed or because a valid evaluation of the information resulting from existing unpublished methods requires an intimate and thorough knowledge of zippers.

5. Sampling

5.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of individual containers from each shipping carton as directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider individual containers from each shipping carton to be the primary sampling units.

NOTE 1—An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between shipping cartons and between zippers in a container to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

5.2 *Laboratory Sample and Test Specimens*—As a laboratory sample for acceptance testing, take the number of zippers specified in Section 7 at random from each container in the lot sample. Consider the zippers as both the laboratory sample and the test specimens.

6. Test Specimen

6.1 The test specimen shall consist of a completely assembled zipper or length of chain.

7. Number of Specimens

7.1 *All Properties Except Slider Mouth Width*—Take a number of zippers per individual container from each shipping carton such that the user may expect at the 90 % probability level that the test result for an individual container is no more than the amounts shown in Table 1, above or below the true average for the individual container. Determine the number of zippers per individual container as follows:

7.1.1 *Reliable Estimate of s or v*—When there is a reliable estimate of *s* or *v* based upon extensive past records for similar materials tested in the user's laboratory as directed in these test

TABLE 1 Specimens Required Under Conditions of Known and Unknown Variability in User's Laboratory Units as Indicated

Property	Allowable Variation (Two-Sided)	Equation for *n* Using a Reliable Estimate of *s* or *v*	No Reliable Estimate of *s* or *v*	
			Number of Specimens	Basis[A]
Length, assembled zipper, % of the average	10.0	$n = 0.027 \times v^2$	1	0.70
Length, chain, % of the average	10.0	$n = 0.027 \times v^2$	1	0.39
Length, top tape end, % of the average	10.0	$n = 0.027 \times v^2$	1	4.56
Length, bottom tape end, % of the average	10.0	$n = 0.027 \times v^2$	3	9.09
Length, opening, % of the average	10.0	$n = 0.027 \times v^2$	1	0.87
Effective tape width, % of the average	10.0	$n = 0.027 \times v^2$	1	2.34
Full tape width, % of the average	10.0	$n = 0.027 \times v^2$	1	2.51
Chain thickness, % of the average	10.0	$n = 0.027 \times v^2$	1	0.64
Chain straightness, 1/32-in. increments	1.0	$n = 2.71 \times s^2$	1	0.59
Wet dimensional change, home laundry, percentage points	0.200	$n = 67.6 \times s^2$	17	0.49
Wet dimensional change, launder-ometer, percentage points	0.200	$n = 67.6 \times s^2$	12	0.41
Dimensional change in dry heat, percentage points	0.200	$n = 67.6 \times s^2$	10	0.38

[A] The values of *s* or *v* in Table 1 are somewhat larger than will usually be found in practice (see 7.1.2).

methods, calculate n using the equations in Table 1 which are based on (Eq 1) or (Eq 2):

$$n = \frac{t^2 \times s^2}{E^2} \quad (1)$$

$$n = \frac{t^2 \times v^2}{A^2} \quad (2)$$

where:

n = number of specimens (rounded upward to a whole number),
s = reliable estimate of the standard deviation of individual observations in the user's laboratory under conditions of single-operator precision,
v = reliable estimate of the coefficient of variation of individual observations in the user's laboratory under conditions of single-operator precision,
t = 1.645, the value of Student's t for infinite degrees of freedom, for two-sided limits, and a 90 % probability level ($t^2 = 2.706$), E and A = values of the allowable variations listed in Table 1, and t^2/E^2 and t^2/A^2 = the basis for calculation of the constants in the equations in Table 1.

7.1.2 *No Reliable Estimate of s or v*— When there is no reliable estimate of s or v for the user's laboratory, (Eq 1) or (Eq 2) should not be used directly. Instead, specify the number of specimens shown in Table 1. This number of specimens is calculated using values of s or v, which are listed in Table 1, and that are somewhat larger values of s or v than are usually found in practice. When a reliable estimate of s or v for dimensional change or length of bottom end in the user's laboratory becomes available, the equations in Table 1, which are based on (Eq 1) and (Eq 2), will usually specify fewer specimens than are listed in Table 1 for the condition when there is no reliable estimate of s or v.

7.2 *Slider Mouth Width*—Unless otherwise agreed upon, as when specified in an applicable material specification, take one specimen per lot.

8. Conditioning

8.1 For tests made as directed in Sections 12, 18, 37, 41, and 49, bring the specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles as directed in Practice D 1776. Preconditioning is not required.

8.2 For tests made as directed in Sections 25 and 31, specimens need not be preconditioned nor conditioned.

LENGTH OF ZIPPER OR PARTS

9. Summary of Test Method

9.1 The chain or zipper is placed on a flat surface and, with the aid of a suitable scale, the length of the zipper or desired zipper part is determined.

10. Significance and Use

10.1 These measurements are useful in determining conformance with a purchasing specification and suitability for end use products using zippers.

11. Apparatus

11.1 *Scale*, graduated in 0.5 mm or 1/64 in.

12. Procedure

12.1 *Length of Completely Assembled Zipper*—Place the closed zipper flat on a horizontal working surface without tension, aligning the chain over a straight reference line on the working surface. Make marks on the working surface corresponding to the zipper extremities. Remove the zipper and, using the scale, measure the distance between the marks to the nearest 1.0 mm or 1/32 in.

NOTE 2—For the bottom end, the zipper extremities are the bottom of the bottom stop or interlocking element for a nonseparable zipper. The bottom end of a separable zipper is the lowermost tape or reinforcing tape but not the overhang of the fixed retainer. For the top end, the zipper extremities are the top of the top stop, or top of the last element, whichever is the extreme for both nonseparable and separable zippers.

12.2 *Length of Chain*—Place the closed chain, without tension, flat on a horizontal working surface, aligning the chain over a straight reference line on the working surface. Place the scale on one stringer flush alongside the outer edge of the interlockable elements or the outer edge of the bead if the bead extends beyond the elements. Measure the distance between the extreme ends of the chain to the nearest 1 mm or 1/32 in.

12.3 *Length of Tape End*—Place the closed zipper, without tension, flat on a horizontal working surface, aligning the chain over a straight reference line on the working surface. Place the end of the scale against the outermost surface of the outermost stationary component. Measure to the nearest 1.0 mm or 1/32 in. the tape end length along the cord to the outermost point of the pinked or straight-cut edge. In a case where the lengths of the tape ends on the two stringers are different, measure the length of the shorter tape end. This test method is not applicable to tape ends that are cut or pinked on a diagonal in excess of 5° in either direction.

12.4 *Effective Length of Opening, Completely Assembled Zipper*—Place the closed zipper, without tension, flat on a horizontal working surface, aligning the chain over a straight reference line on the working surface. With a sharp-pointed pencil, make a reference mark even with the top of the slider. Move the slider to the extreme open position and make another reference mark even with the top of the slider. Measure the distance between the marks to the nearest 1.0 mm or 1/32 in. This test method is not applicable to separable zippers.

13. Report

13.1 State that the specimens were tested as directed in Sections 9-14 of Test Methods D 2060. Describe the material or product sampled and the method of sampling used.

13.2 Report the following information:

13.2.1 The specific property (or properties) measured,
13.2.2 Number and description, of specimens tested, and
13.2.3 Measured length of each specimen.

14. Precision and Bias

14.1 *Precision*—See Section 53.

14.1.1 Precision of the test method is related to the care with which the operator reads the 1.0-mm (1/32-in.) increments on the scale. The test method, though employing measurement of

a variable, is really descriptive rather than quantitative. The test method has been found satisfactory in commercial use for determining conformity to an established specification.

14.2 *Bias*—The procedure in Test Methods D 2060 for measuring the length of zipper parts has no known bias.

TAPE WIDTH

15. Summary of Test Method

15.1 The chain or zipper is placed on a flat horizontal surface and, with the aid of a scale, the tape width is measured.

16. Significance and Use

16.1 These measurements are used in determining the width of tape available for attachment of the zipper.

17. Apparatus

17.1 *Scale*, graduated in 0.5 mm or 1/64 in.

18. Procedure

18.1 *Effective Width*—Place the specimen, without tension, flat on a horizontal working surface. With the end of the scale at a 90° angle to the outer edge of the tape, place the end of the scale against the outermost edges of the interlockable elements on the bead if the bead extends beyond the elements. Measure the distance beyond the outermost edges of the interlockable elements, or the bead if the bead extends beyond the elements to the outermost edge of the tape, to the nearest 0.5 mm or 1/64 in., using a magnifying glass for greater precision. Take five measurements not less than 25.4 mm (1 in.) apart on each specimen.

18.2 *Full Width*—Measure the total tape width including the bead on the tape end of the fastener. Measure the distance perpendicular to the chain with the scale to the nearest 0.5 mm or 1/64 in. If a tape end does not exist, remove interlockable elements to provide a measuring area.

19. Report

19.1 State that the specimens were tested as directed in Sections 15-20 of Test Methods D 2060. Describe the material or product sampled and the method of sampling used.

19.2 Report the following information:

19.2.1 The specific property (or properties) measured,

19.2.2 Number and description of specimens tested, and

19.2.3 Measured width of each specimen.

20. Precision and Bias

20.1 *Precision*—See Section 53.

20.1.1 Precision of the test method is related to the care with which the operator reads the 0.5-mm (1/64-in.) increments on the scale. The test method, though employing measurement of a variable, is really descriptive rather than quantitative. The test method has been found satisfactory in commercial use for determining conformity to an established specification.

20.2 *Bias*—The procedure in Test Methods D 2060 for measuring the width of zipper tapes has no known bias.

SLIDER MOUTH WIDTH

21. Summary of Test Method

21.1 A slider is cut into its halves and the mouth is then measured.

22. Significance and Use

22.1 The slider mouth width is used only to designate the size of the zipper.

23. Apparatus

23.1 *Leaf-Type Taper Gage*, graduated in 0.025 mm (0.001 in.).[7]

24. Preparation of Specimens

24.1 Use side-cutting pliers, a jeweler's saw, or other suitable instrument to sever the slider through the diamond and to separate it into its front and back sections.

25. Procedure

25.1 When the slider has flanges on both the front and back sections, measure the mouth width on the front half. When the slider has flanges on only one half, the measurement is made on that half.

25.2 Measure the mouth width to the nearest 0.025 mm (0.001 in.) by inserting a leaf-type taper gage through the mouth of the slider. Take the measurement between the vertical parallel sides of the flanges at their narrowest point between the slider mouth and the leading edge of the diamond.

26. Report

26.1 State that the specimens were tested as directed in Sections 21-27 of Test Methods D 2060. Describe the material or product sampled and the method of sampling used.

26.2 Report the following information:

26.2.1 Number and description of specimens tested,

26.2.2 Width of zipper slider mouth,

26.2.3 Acceptable range of nominal slider mouth widths for zippers of that size as specified in Specification D 3657, and

26.2.4 A statement that the sample does or does not conform to the nominal slider mouth width.

27. Precision and Bias

27.1 *Precision*—No statement on the precision of the procedure in Test Methods D 2060 for measuring slider mouth width is being made, since the test result is merely used to determine into which of several slider mouth width ranges the specimen falls.

27.2 *Bias*—The procedure in Test Methods D 2060 for measuring slider mouth width has no known bias.

CHAIN THICKNESS

28. Summary of Test Method

28.1 A special gage is used to determine chain thickness under prescribed conditions.

29. Significance and Use

29.1 This test method is useful for determining chain thickness in conjunction with the design of sewing aids such as folders.

[7] A suitable taper gage is available from the L. S. Starrett Co., Athol, MA 01331.

30. Apparatus

30.1 *Dial Thickness Gage.*[8]

31. Procedure

31.1 Hold the specimen manually in a vertical position such that the thickness direction of the chain is perpendicular to the anvils of the gage. Close the jaws of the gage firmly on the chain, taking care that the anvil faces span the chain from shoulder to shoulder and that there is no movement of the elements from their original plane. Make five measurements on each specimen not less than 25.4 mm (1 in.) apart, reading the dial of the gage to the nearest 0.001 in. (0.025 mm).

NOTE 3—For the zipper construction where the interlocking elements are attached in such a way that the tape laps the interlocking elements and the slider encompasses the tape, include the tape in the measurement taken (see Fig. 3 of Terminology D 2050).

32. Report

32.1 State that the specimens were tested as directed in Sections 28-32 of Test Methods D 2060. Describe the material or product sampled and the method of sampling used.

32.2 Report the following information:

32.2.1 Number and descriptions of specimens tested, and

32.2.2 The thickness of each chain specimen.

33. Precision and Bias

33.1 *Precision*—See Section 53.

33.2 *Bias*—The procedure in Test Methods D 2060 for measuring the chain thickness of zippers has no known bias.

CHAIN FLATNESS

34. Summary of Test Method

34.1 Departure from flatness is determined by passing a vernier height gage over the length of the zipper to determine if the number of contacts made exceeds the number agreed upon by the purchaser and the seller.

35. Significance and Use

35.1 Flatness of the zipper chain is important in its application to and appearance of the end use product.

36. Apparatus

36.1 *Surface Plate*—A toolmaker's surface plate at least 300 by 300 mm (12 by 12 in.).

36.2 *Height Gage*, 152 mm (6 in.) vernier, permitting zero measurement at the base surface. The indicating anvil should be square with and parallel to the chain surface and should extend the full width of the chain.

37. Procedure

37.1 Place the specimen upon the surface plate without tension or pressure, with one tape edge aligned with the edge of the plate. Expose the specimen in the state described to the standard atmosphere for testing textiles for 24 h. Set the vernier height gage to the thickness of the chain plus the desired amplitude for the size chain being measured. Place the vernier height gage on the surface plate so that the indicating bar is positioned over the chain surface. Move the vernier height gage along the entire length of the specimen chain and note the number of contacts made with the chain. Do not make any measurements within 25.4 mm (1 in.) of the slider or extremities of the specimen.

NOTE 4—The amplitude of wave to which the gage should be set is that previously agreed upon by the purchaser and the seller.

38. Report

38.1 State that the specimens were tested as directed in Sections 34-39 of Test Methods D 2060. Describe the material or product sampled and the method of sampling used.

38.2 Report the following information:

38.2.1 Number of specimens,

38.2.2 Level of inspection in MIL Standard 105D agreed upon by the purchaser and seller,

38.2.3 Number of contacts per inch for each specimen tested and the number of specimens failing to meet the acceptance criteria, and

38.2.4 Whether the lot was accepted or rejected.

39. Precision and Bias

39.1 *Precision*—See Section 53.

39.1.1 Precision of the test method is related to the care with which the operator notes the contacts made by the height gage. The test method, though employing measurement of a variable, is really descriptive rather than quantitative. The test method has been found satisfactory in commercial use for determining conformity to an established specification.

39.2 *Bias*—The procedure in Test Methods D 2060 for measuring the chain flatness of zippers has no known bias.

CHAIN STRAIGHTNESS

40. Summary of Test Method

40.1 Departure from straightness is determined by means of the height of the arc above a chord of predetermined length which delineates the segment of chain to be evaluated.

41. Significance and Use

41.1 Straightness of the zipper chain is important in its application to and appearance of the end use product.

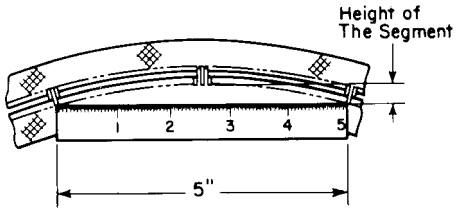
42. Procedure

42.1 Place the complete zipper or zipper chain, without tension, flat on a horizontal working surface. Place a 127-mm (5-in.) straightedge along the chain to form a chord intersecting any apparent curve in the line of the outermost edges of the interlockable elements or the bead if the bead extends beyond the elements. Measure to the nearest 1.0 mm or (1/32 in.) the maximum height of the curved segment as shown in Fig. 1.

43. Report

43.1 State that the specimens were tested as directed in Sections 40-44 of Test Methods D 2060. Describe the material or product sampled and the method of sampling used.

[8] A suitable gage is available from the Fred V. Fowler Co., Inc., P.O. Box 299, Newton, MA 02166, as Dial Thickness Gage No. 52-550-020.



NOTE 1—Use 127 mm scale graduated in 1.0 mm.
FIG. 1 Method of Measuring Chain Straightness

43.2 Report the following information:
43.2.1 Number and description of specimens, and
43.2.2 The height of the curved segment of each specimen.

44. Precision and Bias

44.1 *Precision*—See Section 53.

44.2 *Bias*—The procedure in Test Methods D 2060 for measuring the chain straightness of zippers has no known bias.

LONGITUDINAL DIMENSIONAL CHANGE

45. Summary of Test Method

45.1 Specimens are suitably marked and the distance between the marks is determined. Then the zippers are subjected to washing by either of two optional procedures, or to dry heat or to drycleaning, after which the specimens are checked for any change in length. The change is expressed as a percentage of the length before exposure.

46. Significance and Use

46.1 Dimensional change is important to zipper appearance and to its compatibility with the fabric with which it will be used.

47. Apparatus

47.1 *Measuring Device*, consisting of two clamps, one fixed and one movable both in a horizontal plane, with provisions to take specimens at least 61 cm (24 in.) long. The clamps shall have appropriate cutouts to extend over and clear the chain, so that the clamps will grip the tape only. The movable clamp shall be attached to a cable which runs to the end of the working surface and thence over a grooved pulley mounted on ball bearings. A 57-g (2-oz) weight (including the weight of the cable beyond the pulley) shall be attached to the end of the cable. The clamps and pulley shall be positioned in such a manner that they are in line with the specimen which rests on the working surface. The working surface shall be of smooth glass.

47.2 *Scale*, graduated in 0.5 mm or 1/64 in.

47.3 *Automatic Washing Machine*, as specified in AATCC Method 143.

47.4 *Automatic Tumble Dryer*, as specified in AATCC Method 143.

47.5 *Detergent*, any domestically available household laundry detergent.

47.6 *Heating Oven*, Type II B as described in Specification E 145.

47.7 *Launder-Ometer*.[9]

47.8 *Stainless Steel Cylinder*,[9] 9 × 20 cm (3.5 × 8.0 in.) capacity.

47.9 *Stainless Steel Balls*,[9] diameter 6.3 mm (¼ in.).

47.10 *Drycleaning Machine*, as specified in Test Methods D 2724.[10]

47.11 *Perchlorethylene*, drycleaning grade.

NOTE 5—Perchlorethylene is nonflammable but toxic and the usual precautions for handling chlorinated solvents should be taken.

47.12 *Drycleaning Detergent*, petroleum sulfonate type or amine sulfonate type.[11]

48. Preparation of Specimens

48.1 Prepare the test specimen, which shall consist of completely assembled zipper or length of chain which is between 152 mm (6 in.) and 508 mm (20 in.) long. If the specimen is being prepared from a length greater than 508 mm, a shorter length of chain may be cut out and used as the specimen.

48.2 Insert two staples as bench marks in the tape on one side of the chain as far apart as possible, but at least 6 mm (¼ in.) from the extremities of the chain or zipper. Locate the staples parallel to the chain and at a distance of approximately 3 mm (⅛ in.) from the element shoulders. Squeeze the staples at their extremities to prevent their displacement during subsequent testing. In preparing chain specimens for washing or drycleaning, secure the ends against opening by inserting staples spanning the chain through the tape at the chain extremities.

49. Procedure

49.1 Place the specimen in the clamps of the measuring device under a longitudinal tension of 57 g (2 oz). Measure the distance between the two inner ends of the staples to the nearest 0.5 mm or 1/64 in.

49.2 *Optional Procedure 1—Wet Dimensional Change, Home Laundry Method*—Wash and dry the specimens as directed in AATCC Method 143, Paragraph 8 Procedure, except that any domestically available household laundry detergent may be used in place of the AATCC detergent specified. Wash using Table 11, Machine Cycle (1), Wash Temperature V60 ± 3°C (140 ± 5°F), and tumble dry using Drying Procedure (A)i. One to five washing and drying cycles may be used as agreed upon between the purchaser and the seller. Condition and measure as in 49.4 and 49.5 of this test method.

49.3 *Optional Procedure 2—Wet Dimensional Change, Launder-Ometer Method*—Place the specimen in the cylinder

[9] Available from Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60613.

[10] Sources of suitable equipment are: McGraw-Edison Co., Speed Queen Div., Ripon, WI; Philco-Bendix Corp., Fairfield, IA 52556; American Permac, Inc., 175 Express St., Plainview, NY 11803; Valley Industries Productions, Inc., 133 E. Jericho Turnpike, Mineola, NY 11501; and Atlas Electric Devices, Chicago, IL 60603.

[11] Formula 886, petroleum sulfonate type, or staticol, amine sulfonate type, available from R. R. Street, Inc., 561 W. Monore St., Chicago, IL 60603; or Perksheen 324, amine sulfonate type, available from Adco, Inc., 900 W. Main St., Sedalia, MO 65301, have been found suitable for this purpose.

containing 100 mL of a 0.2 % detergent solution at a temperature of 71°C (160°F) and 100 6.3 mm (¼-in.) steel balls. Close the cylinder and place it in the Launder-Ometer, which is at the required temperature, and run the machine for 45 min. Remove and empty the cylinder and rinse the specimen twice with 100 ± 5 mL of water at 40°C (105°F) by shaking vigorously for 1 min. Remove the specimen from the cylinder and hang the specimen vertically (or, if too long, drape over a bar) in an oven at 68 ± 3°C (155 ± 5°F). Allow the specimen to remain in the oven for 15 min at the specified temperature. Remove the specimen from the oven.

49.4 Condition the specimen from 49.2 or 49.3 as described in 8.1 of these test methods.

49.5 Measure the specimen as directed in 49.1 of this test method.

49.6 *Dimensional Change in Dry Heat Procedure*—Preheat the oven to a temperature between 163 and 177°C (325 and 350°F). Suspend the specimen vertically in the oven and bring the oven back to the 163 to 177°C (325 to 350°F) range. Expose the specimen for 15 min after the oven has returned to the specified temperature range. At the end of the exposure time, remove the specimen and condition it as directed in 8.1 of these test methods.

49.7 Measure the length of the conditioned specimen as directed in 49.1 of this test method.

49.8 *Dimensional Change in Drycleaning Procedure*—Dryclean the specimen as directed in Test Methods D 2724, 10.1 through 10.3, except that during the drying phase of the drycleaning cycle, either (*1*) the air outlet temperature should not exceed 60°C (140°F) or (*2*) the inlet air temperature should not exceed 80°C (175°F). One to five drycleaning cycles may be used as agreed upon between the purchaser and the seller. After the complete drycleaning cycle, remove the specimen from the machine and condition it as directed in 8.1 of these test methods.

49.9 Measure the length of the conditioned specimen as directed in 49.1 of this test method.

50. Calculation

50.1 Calculate the dimensional change of the specimen using (Eq 3):

$$\text{Dimensional Change, percent} = (L - F)\ 100/L \qquad (3)$$

where:

L = original length of specimen, and

F = length of specimen after treatment.

Calculate the average dimensional change of all specimens tested to the nearest 0.1 %.

51. Report

51.1 State that the specimens were tested as directed in the appropriate paragraphs of Sections 45-52 of Test Methods D 2060. Describe the material or product sampled and the method of sampling used.

51.2 Report the following information:

51.2.1 Exposure conditions used, whether wet dimensional change with optional procedure 1 or 2, the dry heat dimensional change procedure, or drycleaning dimensional change procedure,

51.2.2 Average dimensional change and dimensional change of each specimen to nearest 0.1 %, but as percent elongation if the calculated value is negative in sign,

51.2.3 Number of specimens tested, and

51.2.4 Original measured length of each specimen.

52. Precision and Bias

52.1 *Precision*—See Section 53 for the precision of wet dimensional changes and dimensional changes in dry heat. The precision of the procedure in Test Methods D 2060 for dimensional changes during drycleaning is being established.

52.2 *Bias*—The true values of longitudinal dimensional changes in zippers can be defined only in terms of a specific test method. Within this limitation, the procedures in Test Methods D 2060 for measuring longitudinal dimensional changes in zippers have no known bias.

PRECISION AND BIAS

53. Precision and Bias—All Properties Except Slider Mouth Width

53.1 *Interlaboratory Test Data*—An interlaboratory test was run in 1969 in which randomly drawn samples of two materials were tested in each of four laboratories. Each laboratory used two operators, each of whom tested two specimens of each material. The components of variance expressed as standard deviations or as coefficients of variation were calculated to be the values listed in Table 2.

53.2 *Critical Differences*—For the components of variance listed in Table 2, two averages of observed values should be considered significantly different at the 90 % probability level as the differences equal or exceed the differences listed in Table 3.

NOTE 6—The tabulated values of the critical differences should be considered to be a general statement particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established, with each comparison being based on recent data obtained on specimens randomly drawn from one sample of the material to be tested.

53.3 *Bias*—See the statements on bias in the individual test procedures.

54. Keywords

54.1 dimension; zipper

TABLE 2 Components of Variance as Standard Deviations or at Components of Variation, Units as Indicated

Property	Single-Operator Component	Within-Laboratory Component	Between-Laboratory Component
Length, assembled zipper,[A] % of the average	0.50	0.25	0.17
Length, chain,[A] % of the average	0.28	0.00	0.29
Length, top tape end,[A] % of the average	3.26	1.68	0.00
Length, bottom tape end,[A] % of the average	6.49	0.00	3.14
Length, opening,[A] % of the average	0.62	0.34	0.29
Effective tape width,[A] % of the average	1.67	0.54	2.27
Full tape width,[A] % of the average	1.79	0.71	0.00
Chain thickness,[A] % of the average	0.46	0.33	0.00
Chain straightness,[B] 1/32-in. increments	0.42	0.00	0.52
Wet dimensional change, home laundry,[B] percentage points	0.35	0.21	0.76
Wet dimensional change, Launder-Ometer,[B] percentage points	0.29	0.14	0.87
Dimensional change in dry heat,[B] percentage points	0.27	0.00	0.59

[A] Expressed as coefficients of variation.
[B] Expressed as standard deviations.

TABLE 3 Critical Differences for the Conditions Noted, Units as Indicated[A]

Property	Number of Observations in Each Average	Single-Operator Precision	Within-Laboratory Precision	Between-Laboratory Precision
Length, assembled zipper,[B] % of grand average	1	1.2	1.3	1.4
	3	0.7	0.9	1.0
	5	0.5	0.8	0.9
	10	0.4	0.7	0.8
Length, chain,[B] % of grand average	1	0.7	0.7	0.9
	3	0.4	0.4	0.8
	5	0.3	0.3	0.7
	10	0.2	0.2	0.7
Length, top tape end,[B] % of grand average	1	7.6	8.5	8.5
	3	4.4	5.9	5.9
	5	3.4	5.2	5.2
	10	2.4	4.6	4.6
Length, bottom tape end,[B] % of grand average	1	15.1	15.1	16.8
	3	8.7	8.7	11.4
	5	6.8	6.8	9.9
	10	4.8	4.8	8.7
Length, opening,[B] % of grand average	1	1.4	1.6	1.8
	3	0.8	1.1	1.3
	5	0.6	1.0	1.2
	10	0.5	0.9	1.1
Effective tape width,[B] % of grand average	1	3.9	4.1	6.7
	3	2.2	2.6	5.9
	5	1.7	2.1	5.7
	10	1.2	1.8	5.6
Full tape width,[B] % of grand average	1	4.2	4.5	4.5
	3	2.4	2.9	2.9
	5	1.9	2.5	2.5
	10	1.3	2.1	2.1
Chain thickness,[B] % of grand average	1	1.1	1.3	1.3
	3	0.6	1.0	1.0
	5	0.5	0.9	0.9
	10	0.3	0.8	0.8
Chain straightness, 1/32-in. increments	1	1.0	1.0	1.6
	3	0.6	0.6	1.3
	5	0.4	0.4	1.3
	10	0.3	0.3	1.2
Wet dimensional change, home laundry, percentage points	1	0.81	0.95	2.01
	3	0.47	0.68	1.89
	5	0.36	0.61	1.87
	10	0.26	0.55	1.85
Wet dimensional change, Launder-Ometer, percentage points	1	0.68	0.75	2.16
	3	0.39	0.51	2.09
	5	0.30	0.44	2.07
	10	0.21	0.39	2.06
Dimensional change in dry heat percentage points	1	0.63	0.63	1.51
	3	0.36	0.36	1.42
	5	0.28	0.28	1.40
	10	0.20	0.20	1.39

[A] The critical differences were calculated using $z = 1.645$.

[B] To convert values of critical differences expressed as a percent of the grand average to units of measure, multiply the critical difference by the average of the two specific sets of data being compared and then divide by 100.